Low Frequency Receiver Circuit

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1   Design and Comments

The receiver for the solar flare monitor is a simple circuit designed to detect the 24 KHz signal from the station in Cutler, Maine, and reject signals at nearby frequencies from other directions. The receiver uses a commercial amplified loop antenna manufactured by "Palomar" with its "Omega" loop. The loop is approximate 25 cm in diameter and can be oriented in any direction. In a concrete and wood building away from significant structural iron the plane of the loop is vertical and its normal is approximately along a line directed from Louisville, KY, to Cutler, ME. This antenna has an internal FET preamp which may be battery operated. In our system the battery is not connected, and the internal circuit has been modified to accept power delivered on the coax from the antenna to the receiver. The amplified RF from the antenna is capacitively coupled to a LC resonator tuned to 24 KHz. This first stage of the receiver is shown in Fig. 1.

The output from the LC resonator connects to an RF 2-stage amplifier shown in Fig. 2. The amplifier uses a commonly available LF353 dual JFET opamp with the first stage as a voltage follower of unity gain, and the second stage with gain $(R_1 + R_2)/R_1 \approx 101$ in this example. The output of this amplifier may be fed directly to an oscilloscope to monitor tuning of the LC circuit and the antenna.
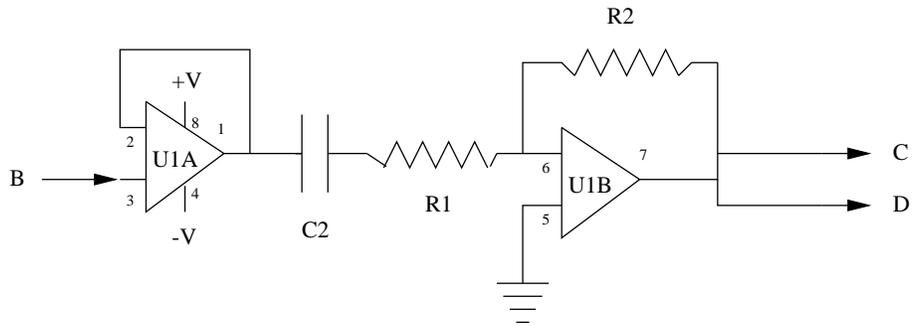
The RF amplifier is capacitively coupled to a detector circuit that rectifies the 24 KHz signal and provides some additional gain. This section also uses an LF353 as shown in Fig. 3.

Additional gain, low-pass filtering, and buffering is provided by a third dual JFET opamp in the section shown in Fig. 4. The gain is adjusted by the resistor R9, which is omitted for 1× or decreased to 10K for 100×. In
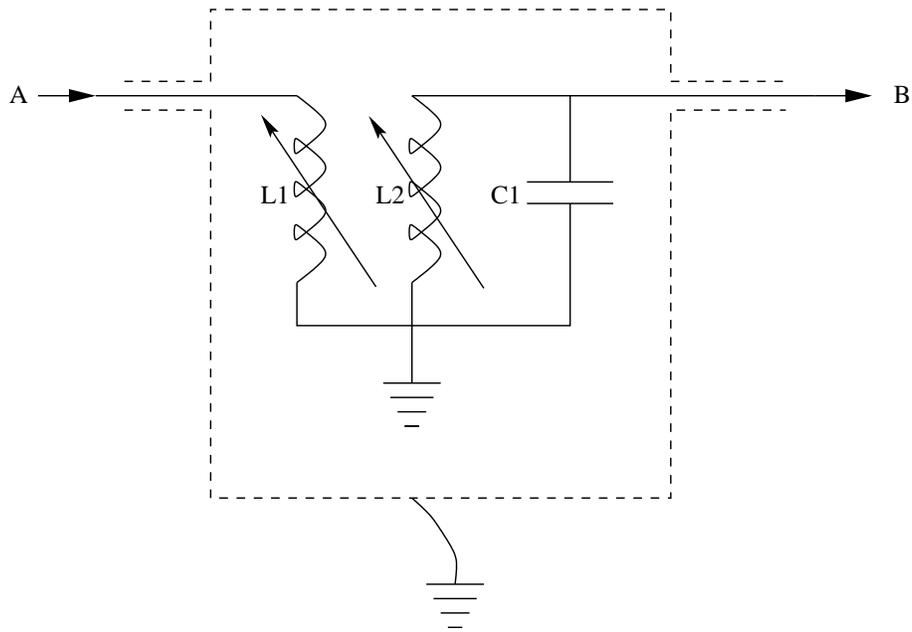
LC Circuit

Figure 1: The LC resonator. A preamplified signal from the antenna enters at **A**. This section is enclosed in a grounded box inside the receiver chassis. The station is selected by varying L2 while monitoring the output of the next stage.

RF Amplifier

Figure 2: The signal **B** from the LC circuit enters a voltage follower (U1A) and is then capacitively coupled to an amplifier (U1B). The output goes to an oscilloscope (**C**) for tuning, and to a detection circuit (**D**).
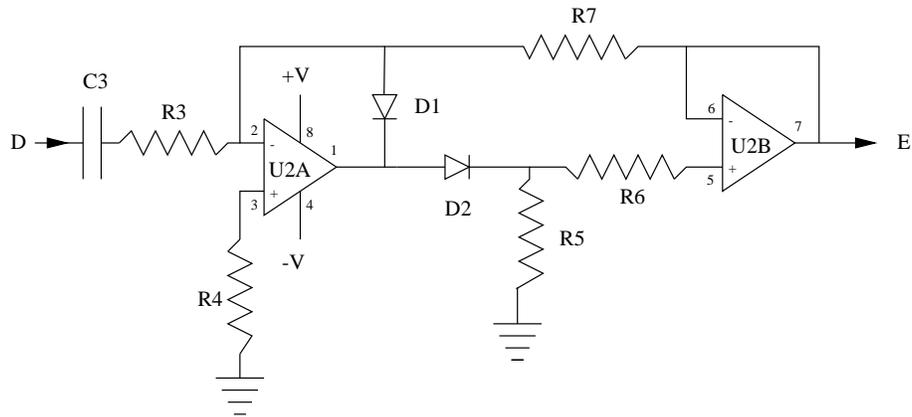
RF Detector

Figure 3: The amplified 24 KHz signal enters at **D**, is capacitively coupled to the first stage (U2A), rectified by D1 and D2, amplified by a second stage (U2B) and connected to an output amplifer at **E**.

C4

R9

R10

+V

R8

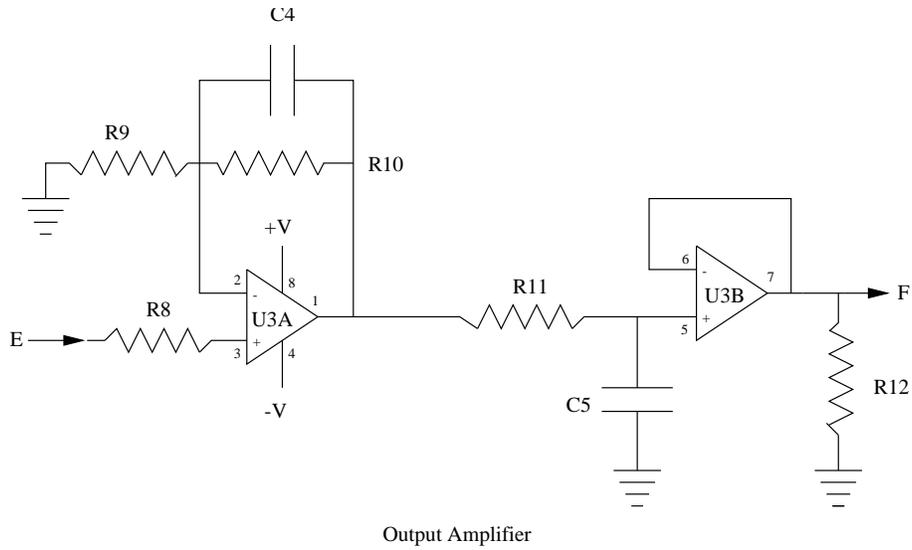E

R11

U3A

U3B

-V

C5

F

R12

Output Amplifier

Figure 4: A halfwave rectified signal from the detector enters at **E** and is amplified by U3A. The time constant is set by adjusting R11 and the output is buffered with the voltage follower U3B.

this version it is set to 225×. The time constant is R11×C5 and is set to 5 s here. The resistor R12 provides some output loading of the amplifier and is adjusted to minimize noise. It leads to a BNC jack on the front panel of the amplifier and a 50 Ω cable connects from there to the analog-to-digital converter at the computer. An additional RC filter is located at the A-to-D to properly terminate this cable and minimize noise.

2 Reference

Components	
Label	Description
L1	(Miller 6318) 0.3 to 3.0 mH
L2	(Miller 6319) 8 to 60 mH
C1	549 pf + 1050 pf + 1500 pf
C2	910 pf
C3	0.047 μf
C4	100 pf
C5	1 μf
D1	1N914
D2	1N914
R1	1 KΩ
R2	100 KΩ
R3	22 KΩ
R4	15 KΩ
R5	10 KΩ
R6	2.2 KΩ
R7	22 KΩ
R8	10 KΩ
R9	4.4 KΩ
R10	1 MΩ
R11	5 MΩ
R12	33 KΩ
U1	LF353 dual JFET op amp
U2	LF353 dual JFET op amp
U3	LF353 dual JFET op amp
	$\pm$V decoupled with 0.1 μf at chip

Connections	
A	Coaxial cable input from antenna preamplifier
B	Coaxial cable output from shielded LC circuit
C	BNC connector to oscilloscope
D	Interconnection to detector circuit
E	Interconnection to output buffer
F	BNC connector to A-to-D converter

Very Low Frequency Radio Stations			
Site	ID	Frequency KHz	Radiated Power KW
Cutler, ME	NAA	24.0	1000
Jim Creek, WA	NLK	24.8	250
Lualualei, NI	NPM	21.4	566
LaMoure, ND		25.4	
Aquada, Puerto Rico	NAU	40.75	100
Keflavik, Iceland	NRK	37.5	100
Niscemi, Italy		39.9	25
Harold E. Holt, Australia	NSW	19.8	1000
Rhauderfehn, Germany		18.5	500
Rosnay, France	HWU	15.1	400
St. Assie, France	FTA	16.8	23
Bombay, India		15.1	
Tavolara, Italy	ICV	20.27	43
Ebino Huyshu, Japan		23.4	
Noviken, Norway	JXN	16.4	45
Arkhanghelsk, Russia	UGE	19.4	150*
Batumi, Russia	UVA	14.6	100*
Kaliningrad, Russia	UGKZ	30.3	100*
Matotchkinchar, Russia	UFQE	18.1	100*
Vladivostok, Russia	UIK	15.0	100*
Anthorn, United Kingdom	GQD	19.0	42
Criggons, United Kingdom	GBZ	19.6	44
Rugby, United Kingdom	GBR	16.0	45

*Input power